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REVIEWS.

The Carbonic Anhydride of the Atmosphere. By PROFESSOR E. A. LETTS, D.Sc., Ph.D., and R. F. BLAKE, F.I.C., F.C.S. (Plates XVI to XVIII). *The Scientific Proceedings of the Royal Dublin Society*, 1900, Vol. IX (N. S.), Part II, pp. 107–270.

THE memoir is divided and separately treated in two parts, the results of which can best be summarized under each division. The extensive review and criticism by the authors of the literature on the amount and causal distribution of atmospheric carbonic anhydride added to the widespread importance of this constituent in aiding certain geological processes, warrant a detailed review of this very valuable paper.

PART I.

Section I is devoted to the "Introduction and Methods of Determination." The first demonstration of the existence of carbonic anhydride in the air was by Dr. Black, of Edinburgh, probably between the dates 1752 and 1754. Many different processes have been employed since De Saussure's time (1796) to determine atmospheric carbonic anhydride, but only the more important ones are considered in this paper. The authors state that with the exception of several methods based on the physical properties of gases, all the processes depend on the employment of an alkali or alkaline earth as an absorbent; and the amount of carbonic anhydride absorbed is determined by one of several methods, among the most important of which are: (1) increase in the weight of the absorbing apparatus; (2) determination of the excess of the absorbent; (3) liberation and measurement of the absorbed carbonic anhydride. A rather extended review of the work of numerous investigators following these methods, in which the more essential points in each method as developed by the individual worker, are brought out and discussed in a brief manner.

Section II is a description of "The Authors' Experiments on Pettenkofer's Process as Modified by Them." A set of determinations made by the authors of carbonic anhydride in the air of a weaving shed in a linen factory at Belfast, in which the use of the Pettenkofer method failed to give concordant results in duplicate determinations, led to the investigation of this method by the authors. The method finally employed is described in considerable detail, including the preparation of reagents, and the apparatus used are figured. A large number of tests were made on artificial mixtures and subsequently on samples of air collected in the rooms and the grounds of Queen's College, Belfast. The results are recorded in tabular form.

Section III closes Part I of the memoir, in which "The Authors' Experiments on the Action of Baryta Water on Glass and on Silica, and the Disturbing Effect of Soluble Silicates on the Delicacy of the Phenol-Phthalein Colour Reaction," are discussed.

The results obtained are of special interest. The experiments with glass were made on the greenish-white glass of Winchester quarts bottles, using a dilute solution of baryta water of known strength. 1^{cc} of the baryta water is equivalent to 0.1^{cc} of CO_2 at N. T. P. The quantitative results for different time exposures are:

After 48 hours	0.0021 gram of glass.
" 72 "	0.0025 " "
" 72 "	0.0050 " "
" 98 "	0.0062 " "
" 98 "	0.0098 " "

The action of alkalies on glass has been investigated previously by a number of workers, and the results here obtained by the authors are in accord with those of previous investigators in showing the very appreciable effect in a short time with very dilute solutions of the alkali, which increases with the time exposure.

It is of interest here to compare Emmerling's results obtained with boiling weak solutions of caustic potash (400^{cc}) in a flask of 600 to 700^{cc} capacity, whose loss in weight per hour was found to be:

0.25 per cent KOH	0.0115 gram of glass per hour.
0.025 " " "	0.0070 " " "
0.005 " " "	0.0027 " " "

In order to ascertain the exact nature of the action of the baryta water on the glass, a given amount of the $Ba(OH)_2$ solution of variable but known strength was introduced into the stoppered bottles and allowed to remain for a given number of days, when the solution was carefully removed and analyzed by the authors. The results follow in tabular form.

	SiO_2	$Al_2 O_3$ $Fe_2 O_3$	CaO	Alkaline sulphates.
Weak baryta solution.....	0.0045	0.0009	None	0.0024
Stronger " "	0.0094	0.0012	None	0.0009
'Percentage composition of the glass used.........	69.95	2.57	17.21	Alkalies as Na_2O 10.27

The authors' conclusions regarding these results are stated by them as follows:

1. A weak baryta solution acts with relative rapidity on the glass of the Winchester quarts (and probably exercise an appreciable action on most varieties of glass), dissolving silica and alkalies, and smaller quantities of alumina and ferric oxide, but no lime.

2. A stronger solution dissolves more silica but less alkalies, about the same amount of alumina and ferric oxide, and also, as in the previous case, no lime.

An appreciable effect is shown by the authors in the titration of $Ba (OH)_2$ after remaining in contact with the glass; and also on the presence of alkaline or soluble silicates on the delicacy of the phenolphthalein color reaction during titration with an acid.

Similar tests conducted on silica with a weak solution of baryta water indicated a similar action as the glass. Some very interesting quantitative results are recorded.

PART II.

Part II is treated in two sections, and makes up the bulk of the memoir. More than twice the space is given to it (106 pages exclusive of the appendices and bibliography) than is allotted to Part I, which is disposed of in 50 pages. Part II consists of a review and criticism of all authentic and trustworthy data collected from all sources and arranged in tables, which bear on the amount and distribution, and the factors controlling the distribution of carbonic anhydride in the atmosphere under varying conditions. It is more than an ordinary compilation in that the data are discussed fully but briefly and the conclusions warranted are concisely stated. It is not possible to make entirely clear the full value of this part of the report in a review, but that an invaluable service has been rendered by the authors will appear from the following general summary:

Section I considers the amount of carbonic anhydride in the atmosphere. After discussing the effects of a permanent increase and decrease in the present amount of CO_2 in the atmosphere on plant and animal life, and the several theories advanced to account for the source of CO_2 to permanently augment this amount, a table showing the amount of CO_2 in 10,000 volumes of air is given.

The arrangement of the table from left to right includes a number of columns under the following headings: "Date of Observation;" "Observer;" "Locality;" "Number of Observations;" "CO_2 in 10,000 volumes of air, including mean, maximum, and minimum;" "Variation, including absolute and percentage;" "Author." The tabulation vertically is in the order of the date of observation, beginning with the earliest (1797) and ending with the most recent (1897). It includes 124 entries, the largest number of observations included in any single entry being the mean of 566; and the number of observations recorded in the table cover a period of 100 years.

A perusal of the figures indicates that the earliest workers obtained an amount vastly too large, accredited by the authors to the methods used. In 1812 Thenard originated a method which yielded results quite close to the present ones. From this time until about the year 1870 the average normal amount of this constituent in the atmosphere was given at approximately 4 in 10,000 volumes, an amount which is at least 25 per cent. greater than that shown at present in fresh air away from cities and towns, approximately 3 in 10,000 volumes.

Section II discusses the "Causes of Variation." In attempting to review and criticise the variations in the amount of carbonic anhydride in the atmosphere, the authors justly appreciate the difficulties encountered, and they state that "not the least of these is to correctly appraise and estimate the value of the evidence brought forward in support of the different contentions which have been raised from time to time in this matter." Only a little study of the work of previous investigators is sufficient to convince one that it has taken nearly a century for chemists to correctly estimate the average amount of this constituent in the air. The figures have been reduced from 100 to 200 volumes of CO_2, in case of the earliest workers, to 3 volumes in 10,000 volumes of air in recent investigations. Two opposite views have been held concerning the variations, championed by De Saussure and Gay Lussac. A statement of these two opposing views can best be summed up in the words of the authors.

> According to the first of these [De Saussure], considerable variations in the amount of atmospheric carbonic anhydride occur, of a more or less lasting or permanent nature, caused by natural agencies such as the seasons, influence of vegetation, the direction and force of the wind, humectation and desiccation of the soil, day and night, etc.
>
> Gay Lussac, on the other hand, was of opinion that owing to the continued movements of the air, both horizontally and vertically, practically uniform distribution or diffusion of the carbonic anhydride occurs. It must be at once granted, from the evidence which has since been forthcoming that Gay Lussac's opinion is correct to the extent that the variations are much less than De Saussure and others of his school believed and that the average amount of atmospheric carbonic anhydride is much the same under the most diverse conditions of weather, locality, season, etc.

The authors state, on the other hand, that variations of a lasting kind do occur, amounting to at least as much as 10 per cent. of the total quantity.

Variations in the atmospheric carbonic anhydride are discussed by the authors under the following headings: (*a*) Locality and local effects. (*b*) Day and night. (*c*) Influence of vegetation. (*d*) Influence of atmospheric precipitates; (1) fog and mist; (2) rain and snow. (*e*) Influence of wind. (*f*) Influence of the seasons. (*g*) Influence of cloud and sun. (*h*) Influence of height.

The figures obtained by various investigators bearing on each one of the above headings are brought together in tabular form, reviewed and criticised, and conclusions when warranted are deduced.

While the subject of variation of atmospheric carbonic anhydride has been one of long-continued investigation and a wealth of figures accumulated, the results are lacking in uniformity, and more often have been carelessly obtained, and are therefore unreliable, and very often lead to opposite conclusions. Much remains to be done in the way of careful and uniform observation and determination by reliable and painstaking workers before definite conclusions may be looked for. From the mass of figures given by the authors the tendency, however, is certainly strongly in favor of Gay Lussac's opinion, that is, the distribution of atmospheric carbonic anhydride is more uniform and the variations not so great as was formerly held by many.

The memoir concludes with two appendices and an extensive bibliography. Appendix I is entitled "On Ground Air and its Relations to Atmospheric Carbonic Anhydride," in which some very interesting figures are given and important conclusions drawn. Appendix II is on "A Comparison of the Results of Determinations of Carbonic Anhydride by Pettenkofer's Original Process, and the Method proposed by Professor Letts and Mr. Blake, and on the Errors incidental to Pettenkofer's Process." By William Caldwell.

The bibliography contains 305 entries, proportioned as follows: German 128, French 98, and English 79.

THOMAS L. WATSON.

DENISON UNIVERSITY,
Granville, O.

Om de Senglaciale og Postglaciale Nivåforandringer I Kristianiafeltet (*Molluskfaunan*). By W. C. BRÖGGER. Separaftryk af Norges geologiske undersögelse No. 31. Kristiania, 1901.

THIS volume concerns itself primarily with the study of the faunas of Pleistocene time in the vicinity of Christiania, and with the changes of level which the character and distribution of these faunas indicate.

The conclusion is reached that the deep sea bottom adjacent was something like 2600^{m} higher than now when the great ice sheet was on, this inference being based on the existence of shallow water fossils at great depths in the "Norwegian sea."

At the end of the last interglacial epoch the land is thought to have been some 100^{m} higher than now, and that this epoch of elevation continued into the time of the last ice covering. As the ice of the last epoch began to melt, the land began to sink, the subsidence continuing for some time after the retreat of the ice began. At the time of the formation of the outermost moraines, the land was 100^{m} to 125^{m} lower than now. This was the time of the deposition of the older and younger yoldia clays and of the older arca clay. While the ice retreated to the second series of moraines, subsidence continued until the land was 150^{m} to 160^{m} below its present level, when the outermost moraines of the second series were formed, and 180^{m} to 185^{m} below its present level during the formation of the innermost moraines of the same series. There was further sinking as the ice receded to its third halting place, and at that time the land stood about 200^{m} below